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INFLUENCE OF SITKA ALDER ON SOIL FORMATION AND MICROBIOLOGICAL SUCCESSION ON A LANDSLIDE OF ALPINE ORIGIN AT MOUNT RAINIER

by

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ABSTRACT

A Sitka alder seedling, growing on 5-year-old avalanche debris below Mount Rainier, led to increased soil carbon and nitrogen and increased microbial populations over a 3-year period. Over 5 years, avalanche debris decreased in pH from moderately alkaline to slightly acid, and the "soil" surface had become somewhat more consolidated.

The debris and rock, deposited below Emmons Glacier by the 1963 avalanche from Little Tahoma Peak, was first sampled in October 1965 for chemical and microbial analysis.[1/] The samples were extremely low in available nutrients and numbers of micro-organisms as compared with samples from under a clump of Sitka alder (*Alnus sinuata* (Reg.) Rybd.) on an adjacent terminal moraine disgorged by the glacier in 1897. Although only meager amounts of carbon and nitrogen were present in the top 8 inches of the 2-year-old avalanche material, corresponding values for the moraine soil indicated appreciable organic matter from the Sitka alder and its associated mosses and lichens.

[1/] Bollen, W. B., Lu, K. C., Trappe, J. M., Tarrant, R. F., and Franklin, J. F. Primary microbiological succession on a landslide of alpine origin at Mount Rainier. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Note PNW-50, 7 pp., illus. 1967.

We intend to follow development of soil and microbiological succession on the Little Tahoma deposit. To plan timing of the next major sampling, we collected interim soil samples in September 1968, nearly 5 years after original deposit (fig. 1). Methods were the same as in 1965 and sampling sites were comparable, though fewer. In addition, three subsamples, later composited, were taken from immediately around the roots of a 3-year-old Sitka alder that had become established since the 1965 sampling on the new "soil" about 10 meters southwest of the adjacent terminal moraine. This alder had a nodule cluster 3 centimeters in diameter at its root collar. Soil samples were collected, prepared, and analyzed by the methods previously described.[2/]

Results show a striking increase of total carbon, nitrogen (obtained by the Kjeldahl method), ammonium, and, to a minor degree, nitrate under the young alder (table 1). Molds, mostly *Penicillium* sp., were much more numerous near the seedling roots, and numbers of bacteria and percent of *Streptomyces* sp. were nearly double those found in the sample taken about 5 feet from the alder seedling. Compared with 1965 samples of unvegetated debris, this material outside the influence of alder contained twice as much Kjeldahl nitrogen and some ammonium and nitrate nitrogen not detected previously.

Figure 1.--*The avalanche surface was still mostly unvegetated in 1968. Emmons Glacier and Little Tahoma Peak, the source of the avalanche, are in the background.*

During the 3 years between samplings, the pH decreased by two units. From moderately alkaline in 1965, the material changed to slightly acidic in 1968, a drop in

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2/ See footnote 1.

Table 1.--*Chemical, microbial, and mechanical analyses of samples from Little Tahoma avalanche deposits near adjacent moraine; on ovendry basis*

Sample analysis	1965 sample 2[1]	1968	
		Sample 1, away from alder[2]	Sample 2, around 3-year-old alder roots
Detritus........................percent..	87.3	39.3	50.9
-10 Mesh..........................grams..	94.0	649.0	469.0
Water......................percent..	10.6	8.7	9.9
pH	8.7	6.7	6.7
Nitrogen:			
NH_4^+.............parts per million..	(3/)	2.0	35.0
NO_2^-.............parts per million..	(3/)	<.1	<.1
NO_3^-.............parts per million..	(3/)	.9	1.5
Kjeldahl.................percent..	.002	.004	.009
Total carbon...................percent..	.049	.036	.057
C:N ratio	25:1	9:1	6:1
Molds:			
Total...........thousands per gram..	.16	.40	20.5
Penicillia.................percent..	50.0	95.0	100.0
Mucors....................percent..	0	3.0	0
Bacteria:			
Total...........thousands per gram..	37.5	92.5	182.0
Streptomyces...............percent..	16.0	17.0	33.0
Mechanical analysis (-10 mesh):			
+20.......................percent..	27.74	15.64	16.40
+40.......................percent..	19.28	25.26	36.08
+60.......................percent..	7.73	13.03	9.72
+80.......................percent..	7.31	10.59	5.84
+100......................percent..	4.59	5.74	3.95
+150......................percent..	7.13	6.80	5.69
+200......................percent..	5.33	4.38	4.37
-200......................percent..	20.85	18.56	17.95
Total	99.96	100.00	100.00

1/ Near lower edge of main deposit.
2/ Location comparable to sample No. 2, 1965.
3/ None detected.

pH that can be attributed to intensive leaching. Ugolini[3] found a similar but less rapid change of alkaline, uncolonized, unweathered glacial till in Alaska; under contiguous 17-year-old alder (*A. incana* (L.) Moench), the pH dropped to 6.8. Alder, in addition to enriching rocky debris with organic matter and nitrogen, depletes it of carbonates and progressively acidifies it.

The mechanical analyses are not readily interpretable because the avalanche material was extremely heterogeneous. However, in 1968 there was indication of decrease in amount of the coarsest material (+20 mesh) and increase in the next two smaller sizes. It was also evident that the avalanche surface was more compacted than in 1965. Progressive textural differences in soil developing on till have been ascribed by Ugolini[4] to surface washing, frost mixing, and mechanical segregation as well as to variations in the original parent material. In the case of the Little Tahoma avalanche, a factor contributing further to the proportional increase in fine materials was deposition from adjacent moraines and pumice deposits by strong winds which sweep the slopes of Mount Rainier (fig. 2).

Figure 2.--*Dust and fine sand are blown onto the avalanche surface from adjacent moraines and pumice deposits by the strong winds that frequently blow about Mount Rainier.*

3/ Ugolini, F. C. Soil development and alder invasion in a recently deglaciated area of Glacier Bay, Alaska. *In* Biology of alder, J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen (eds.). Northwest Sci. Ass. Fortieth Annu. Meeting, Symp. Proc.1967:115-140, illus. 1968.

4/ See footnote 3.

The influence of invading alder on soil formation in this raw avalanche deposit was strikingly shown by results from this interim sampling. It further confirms Mitchell's[5/] conclusions on the importance of Sitka alder as a colonizer that builds nitrogen content and organic matter of soils on recently glaciated terrain of coastal regions of Alaska.

[5/] Mitchell, W. W. On the ecology of Sitka alder in the subalpine zone of south-central Alaska. *In* Biology of alder, J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen (eds.). Northwest Sci. Ass. Fortieth Annu. Meeting, Symp. Proc. 1967:45-56, illus. 1968.